

Two Test Methods for Personal Protective Clothing Systems in Chemical Environments

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The Domestic Preparedness program uses two different tests to assess the performance of personal protective clothing (PPC) systems in chemical environments. Although measurements of both tests are called protection factors, the quantities are different and have different meanings. We use infiltration tests or absorption tests, depending on the PPC system's characteristics. These tests and the meanings of their results are described.

INFILTRATION TESTS FOR LEVEL-A PPC SYSTEMS

Level-A protective systems are designed to minimize all exposure to materials in the environment. For Level-A systems, we apply infiltration tests. These tests measure the amount of chemical that gets into the protective clothing system from the environment. In these tests, aerosols (fine particles, so small that they stay suspended in air) are used to simulate chemicals in the environment. Aerosols are put into the air outside the PPC system and, as people wear the PPC system and move about, the amount of aerosol entering the PPC system is measured. Aerosol concentration is measured in the air beneath the protective system, about the chest, arm, crotch, and leg. The measurements are reported as protection factors. For infiltration tests, protection factors equal the concentration outside the PPC system divided by the concentration inside the PPC system. This protection factor tells us if chemicals outside the PPC system get inside. The infiltration test also shows how long it takes for chemicals to get inside the PPC system and how movements of the wearer influence aerosol penetration. When no chemicals get inside the PPC system, the wearer is definitely protected.

TESTS FOR OTHER PPC SYSTEMS

Not all PPC systems are airtight, Level-A systems. Other protective systems also provide protection against chemicals in the environment. Although chemicals can get inside these systems, the systems still protect the wearer and reduce toxic hazards. To create a toxic hazard, chemicals must be absorbed into the skin. Further, a sufficient quantity of chemical must be absorbed, before a toxic hazard is produced. Other PPC systems protect because they reduce the amount of chemical that is deposited on the skin and then absorbed. We perform absorption tests on protective systems that we know are not airtight. Absorption tests tell us if chemicals getting into the PPC system create a toxic hazard to the wearer.

These absorption tests are called Man-In-Simulant (MIS) tests. These tests measure chemical absorption at the skin. In contrast, the infiltration tests

measure chemicals in the air beneath the PPC system before the chemical reaches the body. In MIS tests, special samplers are placed on the body under the PPC system. While wearing the PPC system, the test subject performs activities that are often required during response. These activities are performed in a simulant vapor. The simulant vapor is not hazardous. Protective fabric measurements are used to show that the simulant vapor penetrates the materials of the protective system just like the toxic chemical agents of concern. The special samplers absorb the simulant vapor and, from the amount of simulant vapor absorbed by each sampler, we determine how much chemical agent the person would have absorbed if chemical agent vapor were present in the environment. From the amount of absorption, we determine the likelihood of a toxic reaction if the PPC system were used in chemical contamination.

Measurements from MIS tests are also called protection factors. Unfortunately, the same term was chosen to describe the measurements of both MIS and aerosol infiltration tests. Protection factors from MIS tests equal the amount of absorption occurring when no PPC system is used and skin is bare and unprotected, divided by the amount of absorption occurring when the PPC system is used and skin is protected. Protection factors from MIS tests indicate the levels of hazards presented with PPC systems, compared to without them. MIS test protection factors are determined from amounts of absorbed chemical; they are the factors by which toxic hazard is reduced for people using PPC systems. MIS tests show how likely toxic effects are if someone uses a PPC system in chemical contamination. By combining MIS test measurements with estimated contamination levels, we show that PPC systems are safe to use in specific, hazardous environments.

SUMMARY

Infiltration tests tell us if PPC systems leak. They also show how much leakage occurs when the individual moves around and conducts normal activity. Infiltration tests best apply to fully encapsulating, Level-A, protective systems, because these tests measure overall system leakage and show how long it takes the leakage to infiltrate the system. For fully protective, Level-A systems, the aerosol infiltration test should give a high protection factor, indicating very little leakage. When leakage is small enough, hazards are precluded. MIS tests tell us if leakage creates a toxic hazard to the wearer. MIS tests are best suited for systems that are not fully encapsulating. These protective systems do not provide protection factors as high as Level-A systems. We use MIS tests with these systems to evaluate the toxic hazard associated with using the system in a contaminated environment. For protective systems receiving MIS testing, protection factors are not as large as those for Level A systems, however protection factors should be large enough to reduce toxic hazards to an acceptable level for the given emergency situation.

Domestic Preparedness provides both these test results, as appropriate for specific PPC systems, so that responders can compare PPC system performance and better determine how various PPC systems can be used safely, in emergency response.